Hypothesis for Hypersonic Flight development

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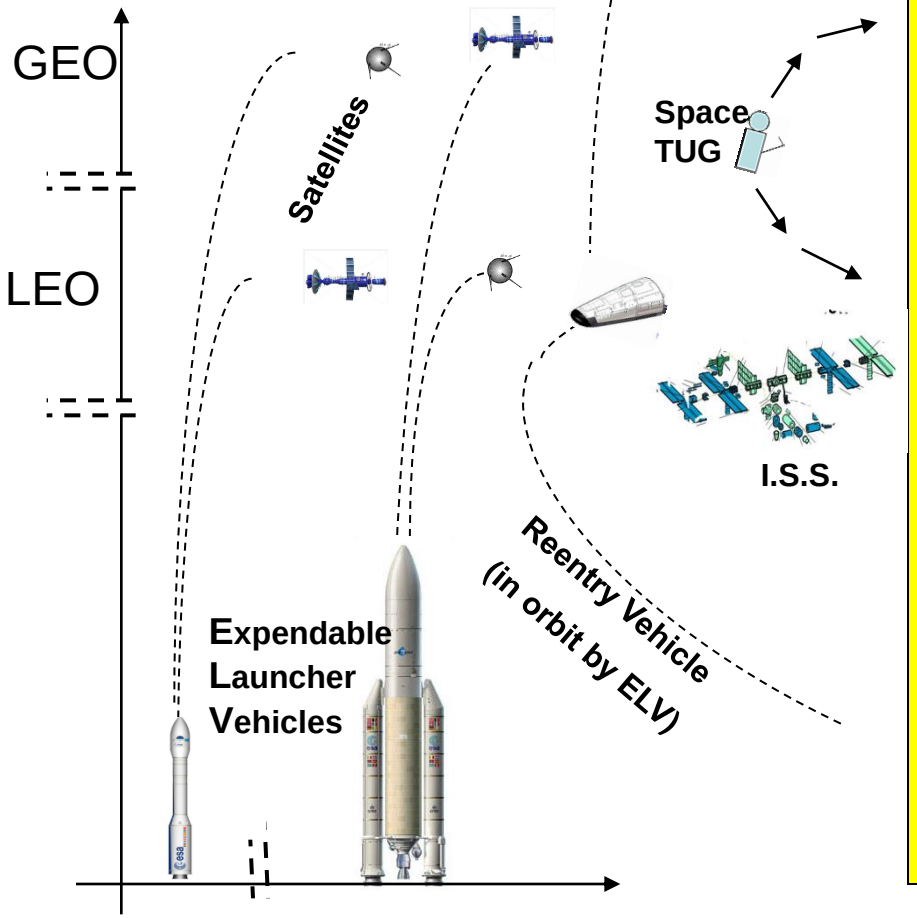
TWO NEEDS

for a (NOT FAR) future

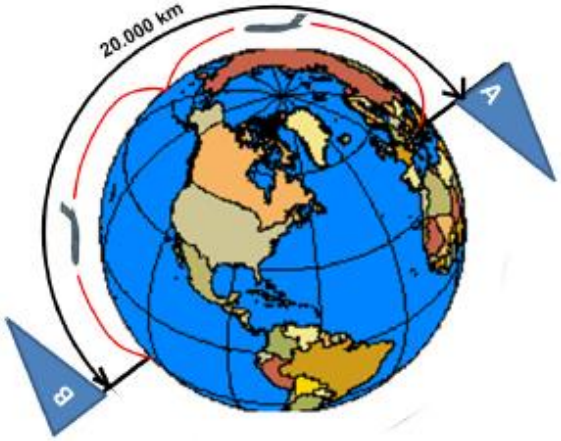
MORE SUSTAINABILITY & MORE RATIONALITY for ACCESS to SPACE

MORE RANGE & TIME REDUCTION for TERRESTRIAL TRIPS

MORE SUSTAINABILITY & MORE RATIONALITY for ACCESS to SPACE

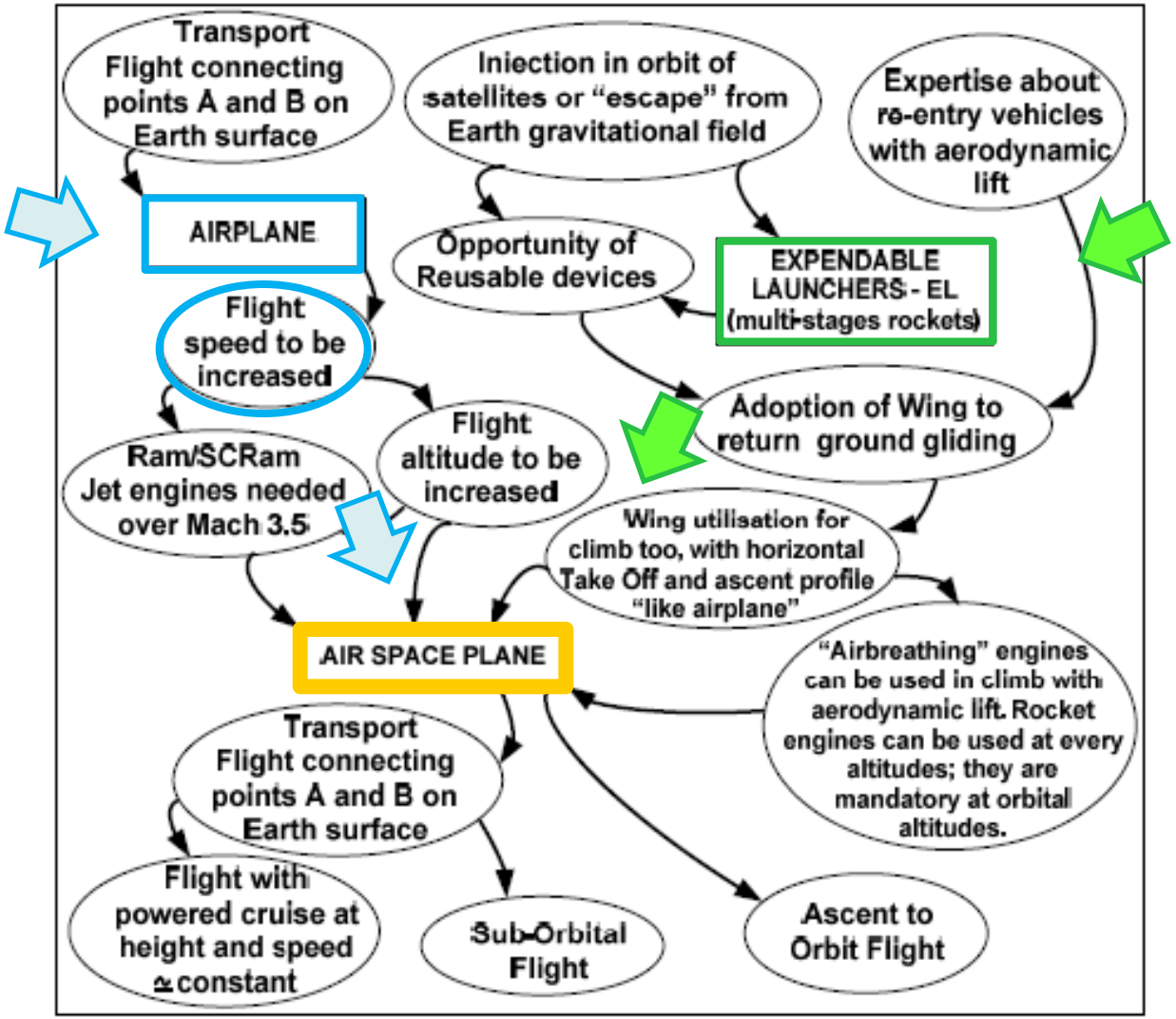


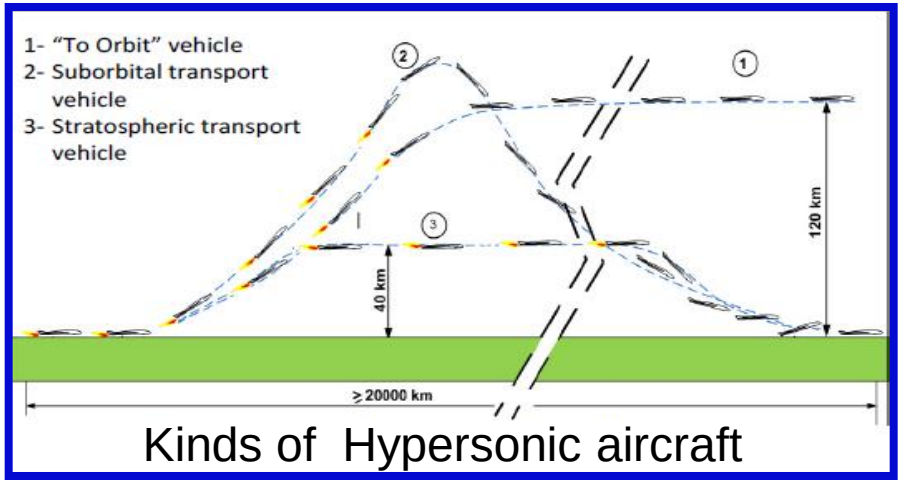
MORE RANGE & TIME REDUCTION for TERRESTRIAL TRIPS



Global flight coverage and today limits

Logic path to define Hypersonic Vehicles typologies





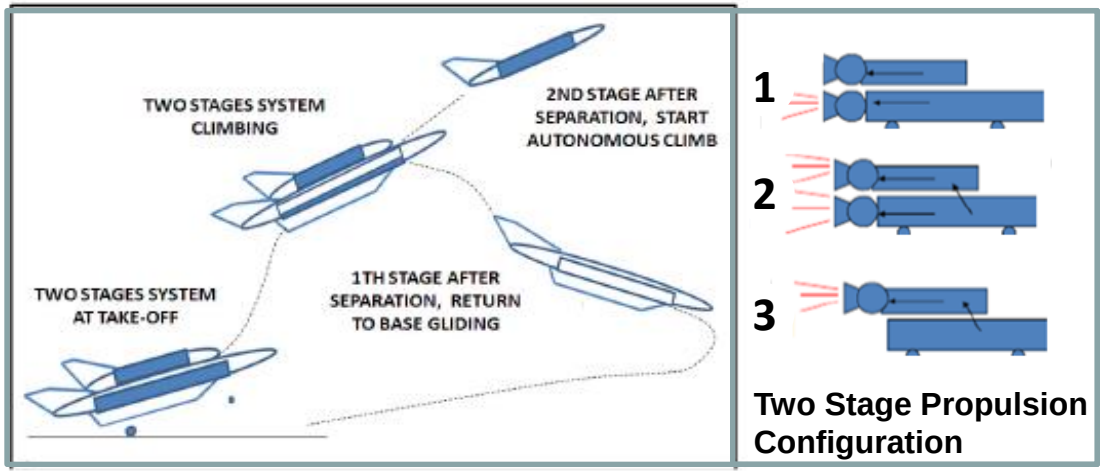
Kinds of Hypersonic aircraft

Different propulsion sequence for Hypersonic Planes

TURBOJET with A.B.	RAM JET			Limited to Mach 6. Typical solution for stratospheric cruise airplanes. Turbojet and Ramjet separated or integrated.
TURBO FAN.	ROCKET	RAM JET		As in previous case but with engines more eco-friendly for low altitude phases of flight. Rocket needed to reach ignition speed of Ramjet.
TURBOJET with A.B.	RAM JET	SCRAM JET		Technology still to be examined in depth. Altitude and speed achievable still to be defined.
TURBOJET with A.B.	RAM JET	SCRAM JET	ROCKET	Orbit achievable. Optimal Engines sequence. System complexity.
TURBOJET with A.B.	RAM JET	ROCKET		As previous case, but avoiding Technology not totally acquired yet.
ROCKET	RAM JET	ROCKET		Orbit achievable. Simple System but high consumption.
ROCKET				Simple System, but very high consumption to orbit; more useful for SubOrbital flights.

Stratospheric transport vehicle

"to orbit" or Suborbital vehicle

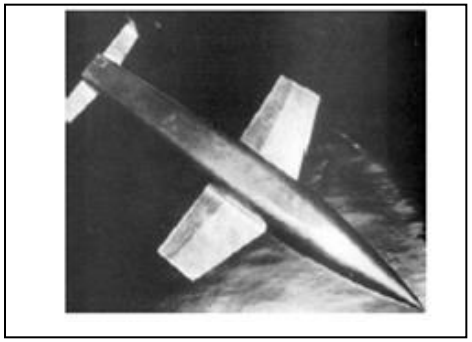


Two Stage Propulsion Configuration

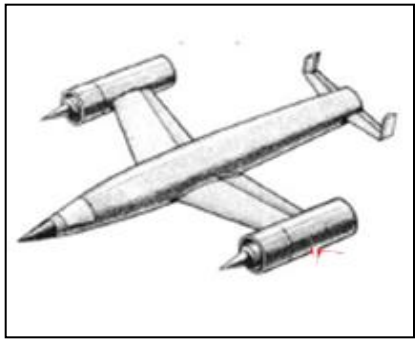
W.W. II

Historical Project

SANGER BOMBER



SOVIET ANTIPODAL BOMBER



1990's

T.S.T.O.SANGER II

S.S.T.O. NASP X 30

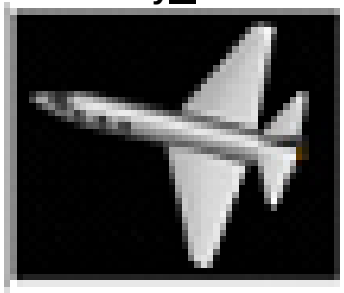
S.S.T.O. HOTOL

Space Tourism

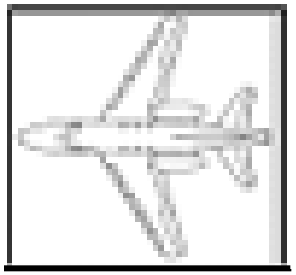
90's and 00's

Bristol ASCENDER

Fund. Techn.Sys. "Aurora"



Pan Aero Inc. "Sabre Rockt"



XCOR "Lynx"

Hypersonic: the future

Hypersonic Transport
Passengers (300 pax)
Mach 5
"Antipodal" range

LAPCAT A2

Type: hypersonic passengers transport	
Pax n°	300
Length	139 m
Wing span	41 m
Wing area	900 m²
Take Off Gross Weight	400.000 kg
Fuel Weight	198.000 kg
Engines	4 Scimitar Cruise
Speed	Mach 5
Range	18700 km
Unit cost (estimated)	639 MC

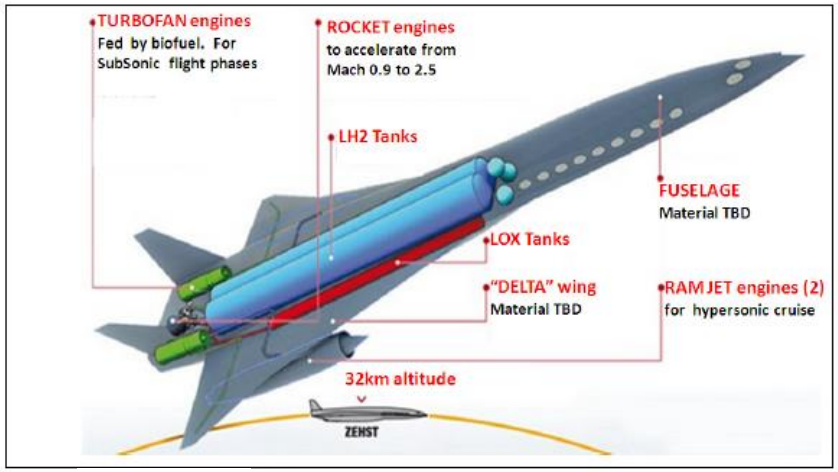
A2 LAPCAT, Pictorial representation, Technical Data

SKYLON
Crew: None, remote controlled from ground.
Capacity: Potential for up to 30 passengers
Payload: 15.000 kg (33,000 lb)
Length: 70 m
Wingspan: 22 m
Fuselage diameter: 6.75 m
Empty weight: 53.000 kg
Loaded weight: 345.000 kg
Powerplant: 2 × SABRE 1,350 kN eachThrust/weight: ~1.2 – 3 at burnout (~0.768 atmospheric)
Specific impulse: 3500 s atmospheric, 450 s exoatmospheric
Service ceiling: 26.000 m air breathing, >200 km exoatmospheric
Maximum speed: Orbital (airbreathing Mach 5.5)

SSTO Derived from HOTOL - 2x SABRE engine ("air-breather" and Rocket)

EADS ZEHST-Zero Emissions HyperSonicTransport

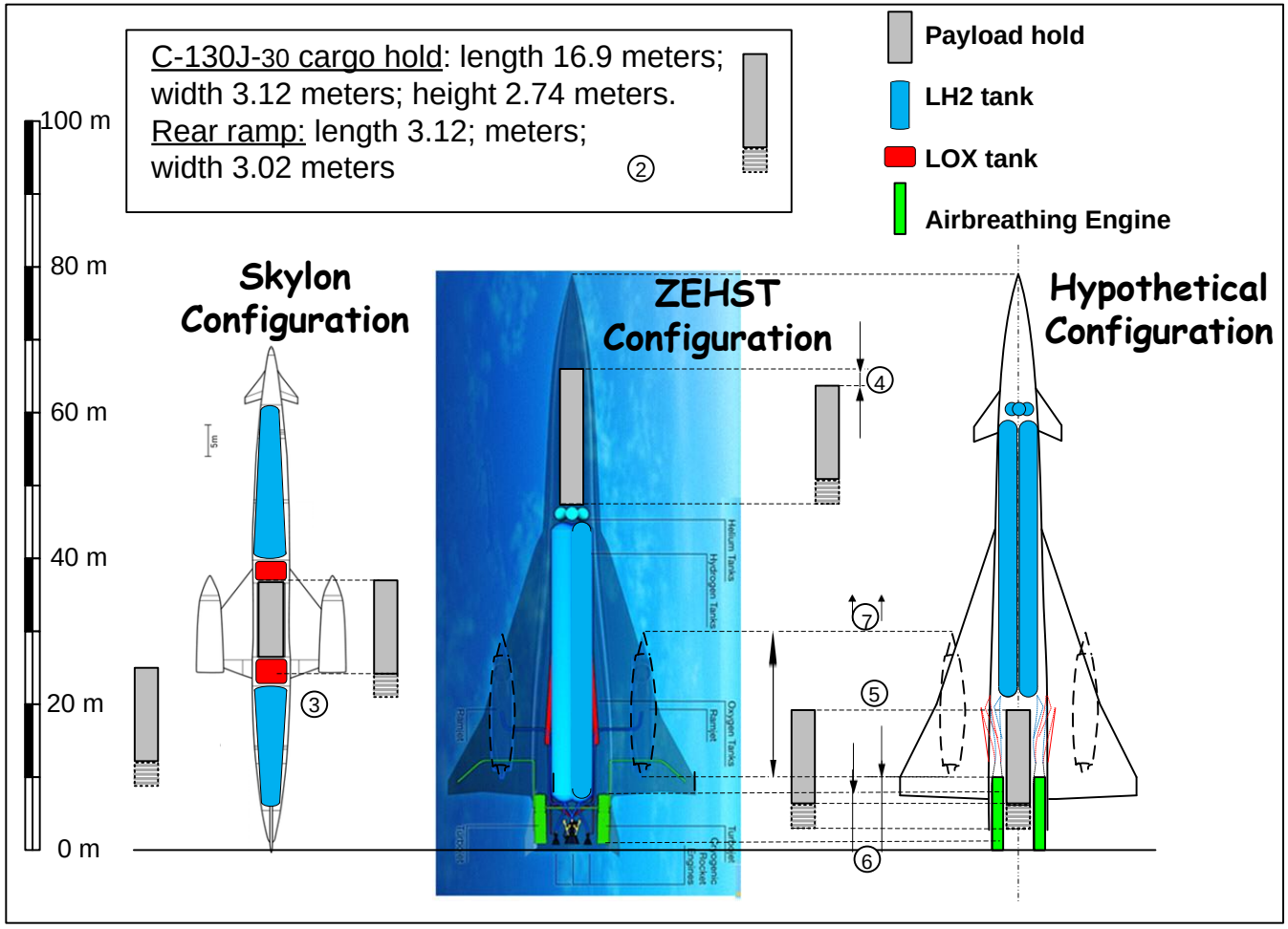
Hypersonic Transport
Passengers (60 pax)
Engine sequence:
-Turbofan (bio fuel)
-Rocket
-Ramjet (LH2)



ZEHST configuration and Vehicle characteristics

Configuration study for a Military Hypersonic Transport

1. Configuration based on ZEHST project
2. Main project requirement: the Cargo-bay has to have the same dimensions of the C-130 one with rear ramp
3. Cargo-bay largest than Skylon one
4. Cargo-bay smallest than ZEHST one
5. The cargo-bay is placed on rear fuselage eliminating the ZEHST rocket engine
6. Need to replace the ZEHST turbofan engine with Turbojet engine with A/B to start Ram-Jet
7. Same Ram-Jets used in ZEHST configuration

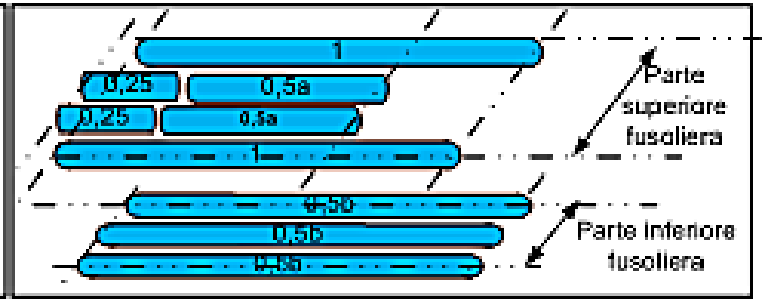


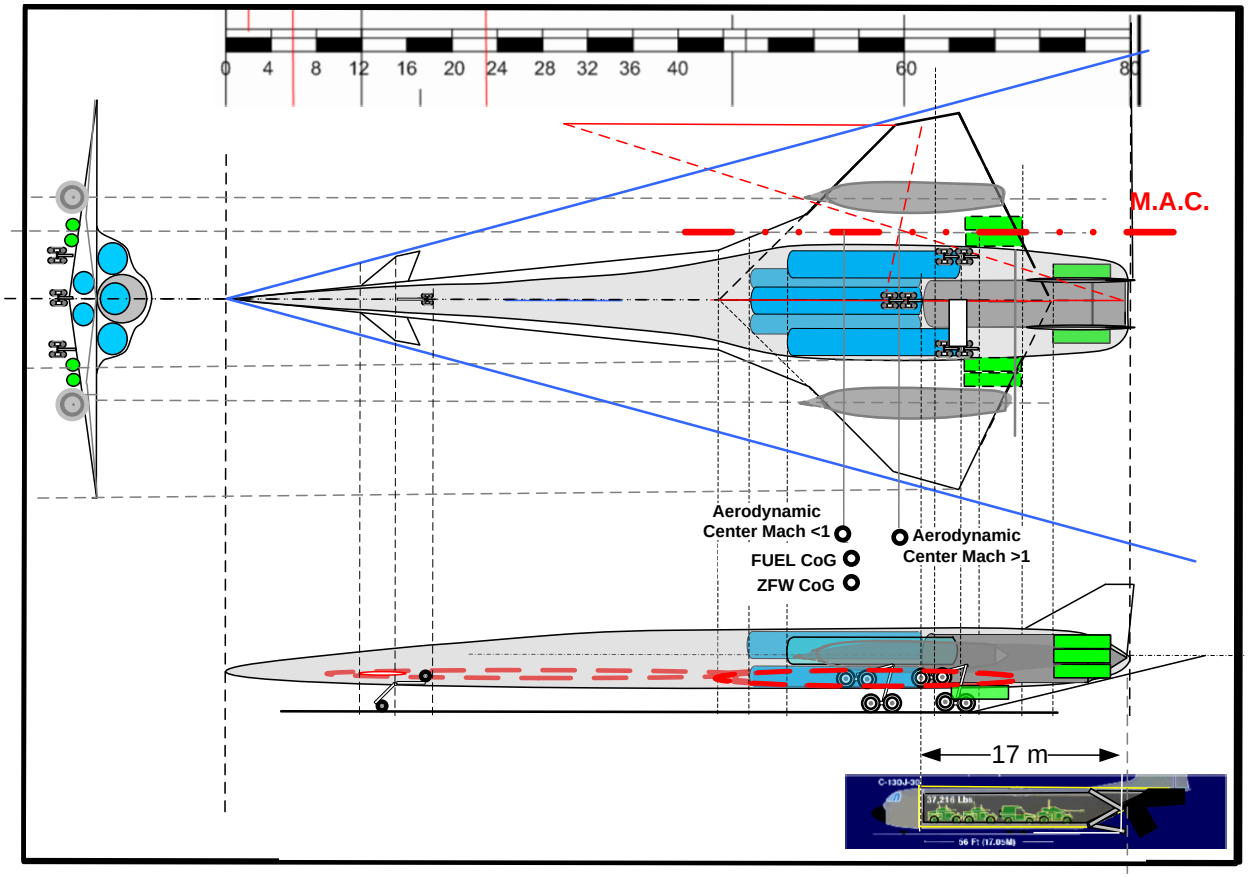
- Considering the better Specific Impulse, during hypersonic cruise the RAM-Jets are fueled by LH2
- **Significant configuration changes** are required to install the LH2 tanks closer to the aircraft C.G. avoiding unacceptable C.G. excursion
- The new configuration stores the necessary LH2 in several tanks placed around the cargo-bay. The aircraft C.G. is now close to the aerodynamic center.
- The volume in the forward fuselage can be used for light payload as Command & Control room or VIPs passengers

TIPO 1 Φ=2,4m; L =36m; Cap.=162 mc
TIPO 0,5a Φ=2,4m; L=18m Cap= 81 mc
TIPO 0,5b Φ=1,7m; L=36m; Cap.= 81mc
TIPO 0,25 Φ=2,4m; L9m; Cap.= 41 mc

Capacità totale= 810 mc LH2
=267.300kg

Kerosene x T.Rott.+AB= 53.000 kg in ala
PESO TOTALE FUEL= 320.000 kg



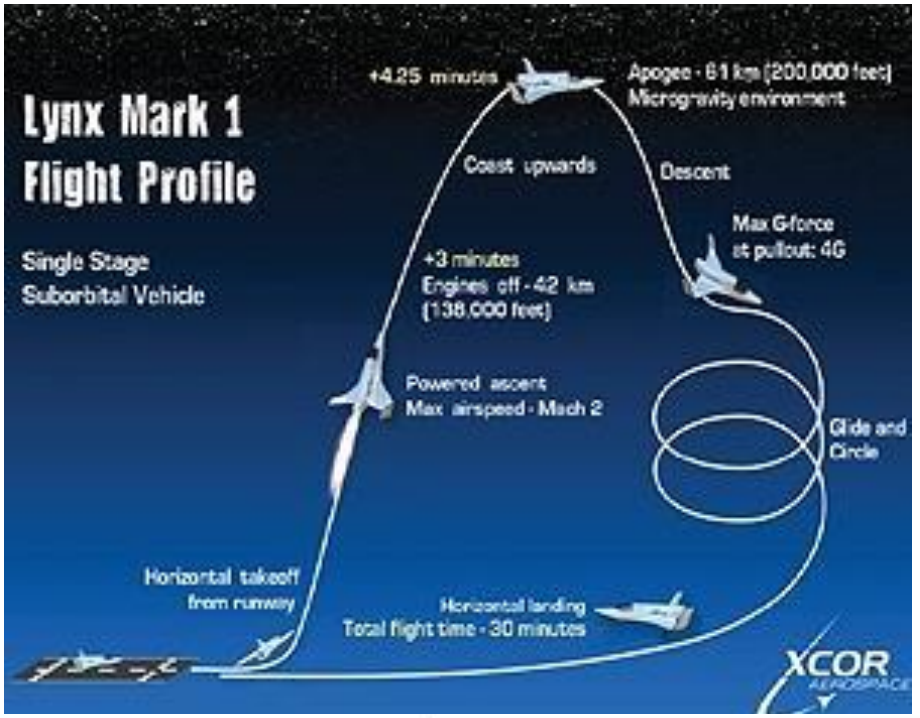


- This unconventional concept study can be useful as basis for discussion
- It is based on a hypothetical requirement of "Global Reach Capability". The result is a configuration study supported by:
  - simple performance calculation (takeoff, climb and cruise)
  - application of simple WERs (weight estimation relationships)
- Certainly, a conceptual and preliminary design or even a development of this kind of aircraft would result in a significant economic commitment

In the following slides, low cost studies are proposed to facilitate the start of the work on hypersonic flight (in Italy, if possible)

SPACE TOURISM

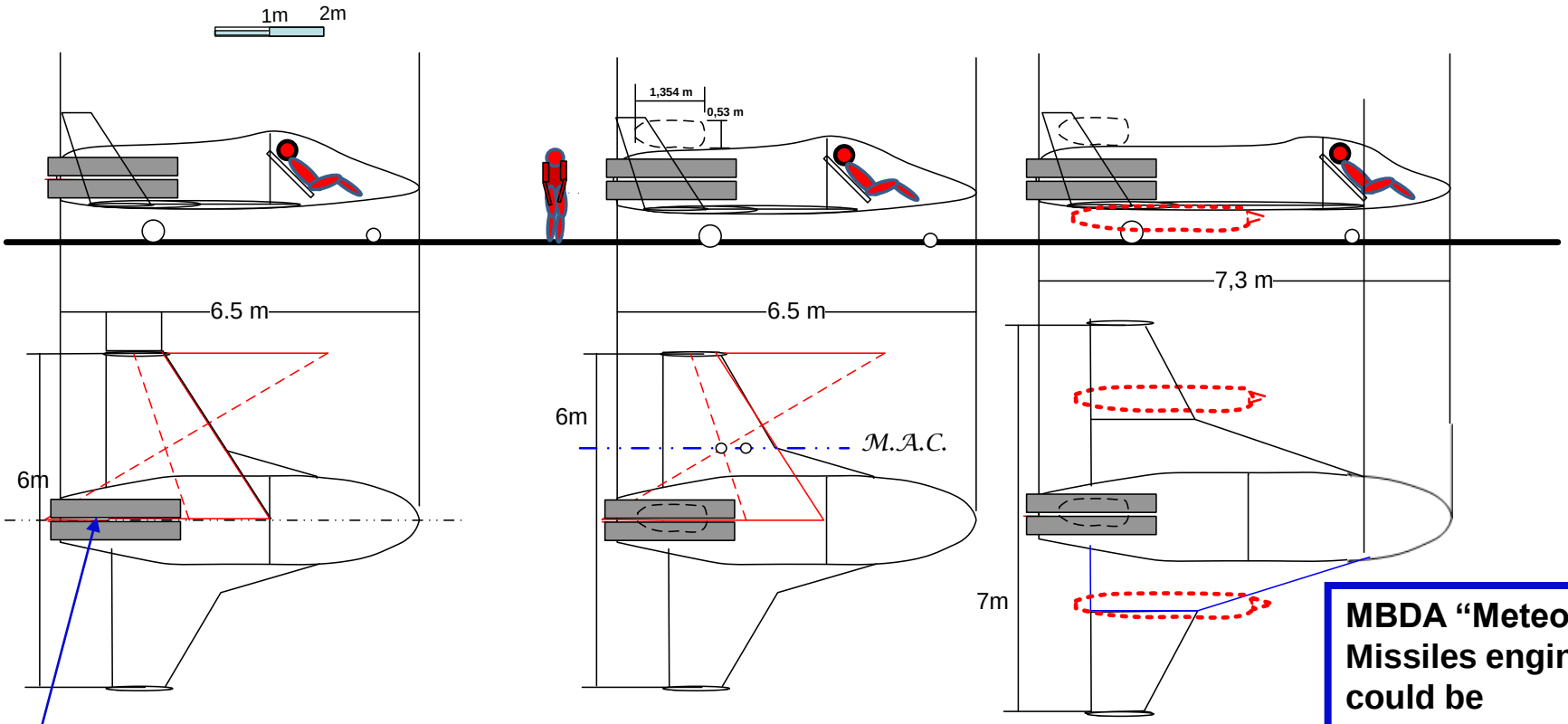
XCOR "Lynx"



VIRGIN GALACTIC AIR SHIP TWO

Space Tourism EADS; pictorial view and passengers cabin layout mock-up

- Performing a sub-orbital flight, for space tourism, does not seem an unachievable task
- The mission profile is relatively simple
- Relatively simple are the aircraft like XCOR Lynx: two-seater, 4 rockets with 1250 kg (each) of thrust. A TOGW = 6000 kg is possible considering 3000 kg of fuel, 200 kg of payload and an empty weight of 2800 kg.
- More complex concepts are based on "business jet aircraft" configuration
- We propose 3 low cost concept to begin thinking on hypersonic flight:
  - developing from XCOR Lynx a simple hypersonic experimental aircraft
  - an hypersonic aircraft based on well known Fighter
  - Hyplane project conceived by Space Renaissance (Italy)



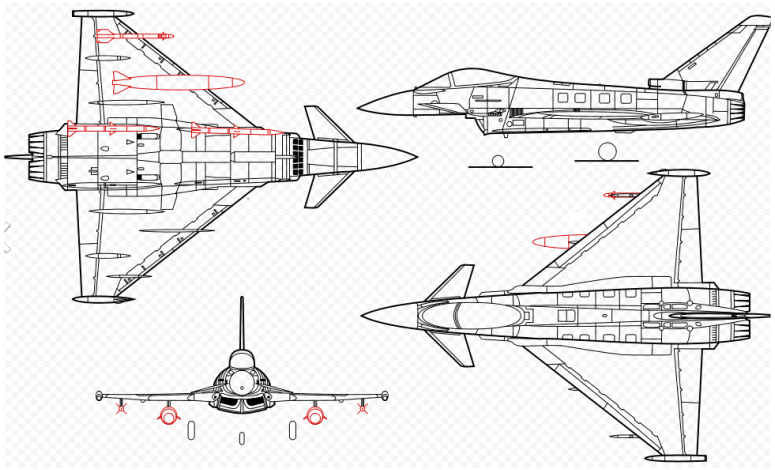
MBDA "Meteor" Missiles engines could be considered?

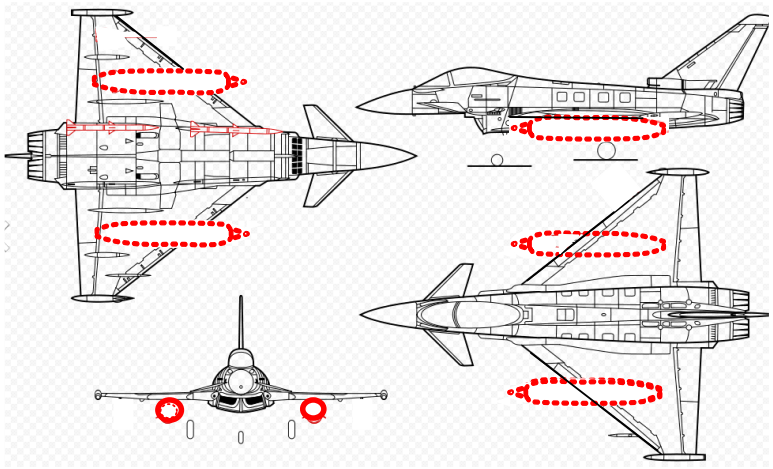
4 LOX-Methane Rocket Engines XCOR XR-5K18

SPECIFICATION WILLIAMS FJ44
L=1,354 m; Φ= 0,531 m; Peso (dry)=209 kg
Thrust =1900 lb; SFC=0,456 lb/lb/h;
By-pass ratio=3,3

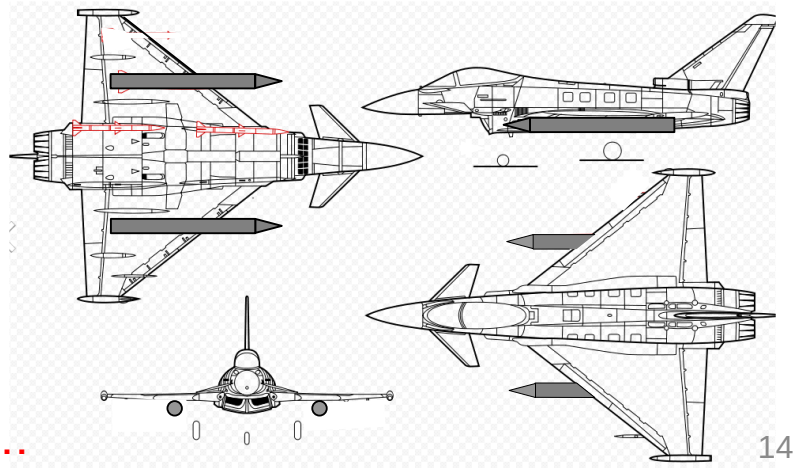
Addition of 2 RAM-JET TBD
L, b and S increased

Installation of 2 RAM-Jets



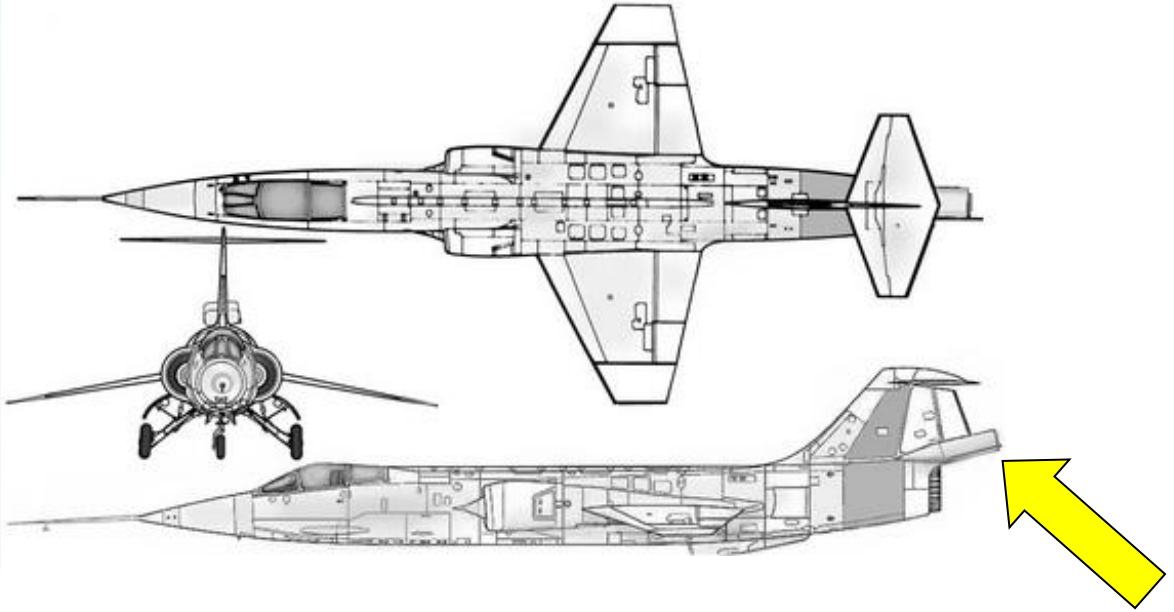


Installation of 2 Rockets



…may be XCOR Engines….

….some time ago…



NF 104 A, modified by NASA, with a supplementary rocket engine, for research purpose


SPACE RENAISSANCE
INITIATIVE
Congresso Nazionale di Space Renaissance Italia
8 - 9 Maggio 2014 - Politecnico di Milano, Bovisa
SPAZIO SENZA FRONTIERE:
UN MONDO PIÙ GRANDE È POSSIBILE!
PROGRAMMA

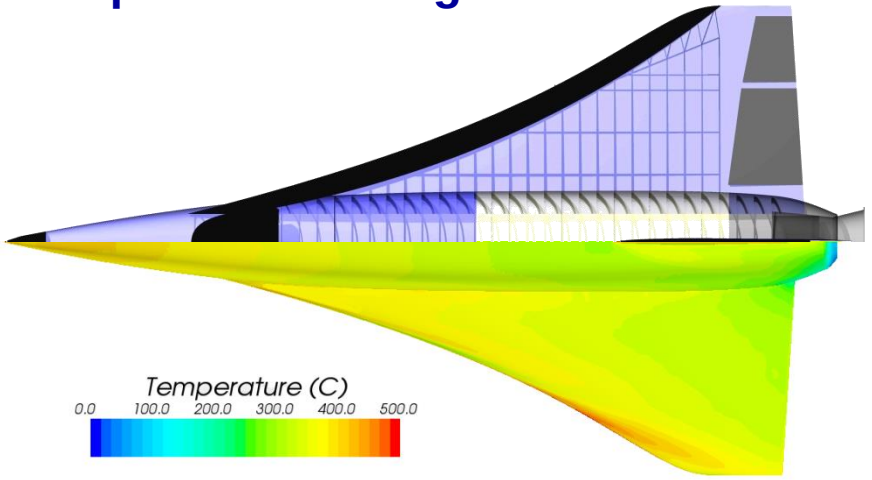
The University of Naples “Federico II”, under the eagis of the Space Renaissance Italia Space Tourism Program and with the support of other Universities and small and medium enterprises, is investigating a new vehicle concept for long-duration space tourism missions and hypersonic point-to-point transportation

Conceived by Raffaele Savino and Gennaro Russo

A personal HYpersonic airPLANE

- 6-seats small Mach 4-4.5 spaceplane
- HTHL within the present rules governing common airports
- Urgent Travel market segment
- Space tourism
- Future reusable first stages of air-breathing space-access vehicles

- can fly a series of Space Tourism parabolas at max altitude above 70 km
- 6000 km distances in less than 2 hours with cruise altitude at about 30 km
- **integrates state-of-art aeronautic and space technologies**



Why don't we try some of these simple experiments?

Sentence inspired by

"From Earth to Moon"

by Jules Verne (1865)